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**United States**

**Title: CONSTRUCTION OF A VACUUM  
CLEANER**

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**Field of the invention**

[0001] This application relates to a vacuum cleaner. In one particular embodiment, this invention relates to an upright or stick vacuum cleaner or sweeper.

5 **Background of the invention**

[0002] Various designs for vacuum cleaners are known in the art. Vacuum cleaners require power to drive a suction fan to cause an airflow, which entrains dirt and transports the dirt to a filtration member. Traditionally, vacuum cleaners have been developed which require a substantial amount of  
10 power input to the suction fan to provide the desired airflow (e.g. 10 to 13 Amp). In order to provide such amounts of power to a vacuum cleaner, the vacuum cleaner is provided with an electric cord that is plugged into an AC outlet in a building.

[0003] Battery operated vacuum cleaners have been developed. These  
15 vacuum cleaners also require a substantial amount of battery power, which limits the run time due to the amount of power required to operate the suction motor. The amount of batteries required to power the vacuum cleaner, have several disadvantages. These include the increased weight of the vacuum cleaner due to the batteries, the additional size of the vacuum cleaner to  
20 accommodate the batteries on board, and the limited operational time of the vacuum cleaner on a single battery charge if the vacuum cleaner is to have a high level of cleaning efficiency.

**Summary of the invention**

[0004] In accordance with the instant invention, a vacuum cleaner is  
25 provided with a suction motor and fan assembly in a main airflow conduit extending between the dirty air inlet, typically in a surface cleaning head, and a filtration member. For example, in an upright or stick vacuum cleaner, an airflow conduit extends from the surface cleaning head to the filtration member in a support (e.g. an upper casing) pivotally mounted to the surface  
30 cleaning head. By positioning the motor and fan assembly in the conduit and

linearly aligning the motor and fan assembly and the conduit, the number of bends in the airflow passage is reduced. Each bend in the airflow passage of a vacuum cleaner creates backpressure and reduces the airflow rate therethrough, unless the power delivered to the motor and fan assembly is increased. Accordingly, in a battery-powered vacuum cleaner, a reduction in the backpressure can result in an increase in the cleaning efficiency of the vacuum cleaner and/or an increase in the run time of the vacuum cleaner on a single battery charge and/or a reduction in the number of batteries.

**[0005]** In accordance with the instant invention, it is preferred to position the suction motor and fan assembly exterior to the surface cleaning head. Typically, in upright vacuum cleaners, the suction motor and fan assembly is positioned in the surface cleaning head. This increases the height of the surface cleaning head and limits the extent to which the vacuum cleaner may use the surface cleaning head to clean under furniture. By positioning the suction motor and fan assembly exterior to the surface cleaning head, and aligning the suction motor and fan assembly with the upper casing, then the depth of the upper casing may be minimized while reducing the height of the surface cleaning head, thereby enhancing the ability of the vacuum cleaner to clean under furniture.

**[0006]** In accordance with the instant invention, there is provided an upright surface cleaning apparatus comprising a surface cleaning head and an upper casing pivotally mounted thereto, the upper casing moveable between a storage position in which the upper casing extends generally vertically upwardly from the surface cleaning head and an in use position, the surface cleaning head having a dirty air inlet, the surface cleaning apparatus having a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage including a conduit extending generally vertically upwardly when the upper casing is in the storage position and a motor and fan assembly positioned in the conduit.

**[0007]** In one embodiment, the upright surface cleaning apparatus further comprises a filtration member positioned in the upper casing and the conduit extends between the surface cleaning head and the filtration member.

**[0008]** In another embodiment, the motor and fan assembly is  
5 positioned adjacent the surface cleaning head.

**[0009]** In another embodiment, the conduit has a longitudinal axis and the motor and fan assembly has an axial flow direction and is positioned in the conduit portion such that the axial flow direction is parallel and coplanar with the longitudinal axis of the conduit.

10 **[0010]** In another embodiment, the conduit extends away from the surface cleaning head.

**[0011]** In another embodiment, the motor and fan assembly is positioned exterior to the surface cleaning head.

**[0012]** In accordance with the instant invention, there is also provided a  
15 surface cleaning apparatus comprising a dirty air inlet, a clean air outlet, an air flow passage extending between the dirty air inlet and the dirty air outlet, the air flow passage in fluid flow communication with a motor and fan assembly, the motor and fan assembly having an axial flow direction and the air flow passage having a portion having a longitudinal axis and a substantial linear  
20 longitudinal extent and the motor and fan assembly is positioned in the portion such that the axial flow direction is parallel and coplanar with the longitudinal axis of the portion.

**[0013]** In one embodiment, the surface cleaning apparatus further comprises a surface cleaning head and a filtration member and the portion  
25 extends from the surface cleaning head to the filtration member.

**[0014]** In another embodiment, the surface cleaning apparatus is an upright or stick vacuum cleaner.

**[0015]** In another embodiment, the portion comprises a generally vertically extending airflow duct when the surface cleaning apparatus is in a

storage position and the motor and fan assembly is provided in the generally vertically extending airflow duct.

**[0016]** In another embodiment, the portion comprises two generally vertically extending airflow ducts and a motor and fan assembly is provided in one of the generally vertically extending airflow ducts.

**[0017]** In another embodiment, the motor and fan assembly and the portion each have a linear extent and the linear extent of the portion is at least about three times the linear extent of the motor and fan assembly.

**[0018]** In another embodiment, the motor and fan assembly and the portion each have a linear extent and the linear extent of the portion is at least about five times the linear extent of the motor and fan assembly.

**Brief description of the drawings**

**[0019]** These and other advantages of the instant application may be more clearly and fully understood in accordance with the following description of the preferred embodiments of this invention as illustrated in the following drawings in which:

**[0020]** Figure 1 is a schematic drawing of a vacuum cleaner according to a first embodiment of this invention;

**[0021]** Figure 1A is a perspective view of the vacuum cleaner in Figure 1 in the storage position;

**[0022]** Figure 2 is an alternate view of the vacuum cleaner of Figure 1 with the dirt collection bin removed;

**[0023]** Figure 3 is a schematic drawing of a vacuum cleaner of Figure 1 wherein the auxiliary above floor cleaning hose has been removed for use in an above the floor cleaning mode;

**[0024]** Figure 4 is a schematic drawing of a rear view of the vacuum cleaner of Figure 1;

**[0025]** Figure 5 is a schematic top plan view of the cleaner head of the vacuum cleaner of Figure 1;

**[0026]** Figure 6 is a cross-section along the line 6-6 in Figure 5 showing a configuration for the air flow pass in the vacuum cleaner head;

**[0027]** Figure 7 is a cross-section along the line 6-6 of Figure 5 showing an alternate configuration for the air flow pass in the vacuum cleaner head;  
5 and,

**[0028]** Figure 8 is a top plan view of an alternate construction of a vacuum cleaner head shown in Figure 5.

**Detailed description of the invention**

**[0029]** As shown in the Figures attached hereto, an upright vacuum cleaner 60 has a floor cleaning head 3 and an upper assembly 62 pivotally  
10 mounted thereto. It is to be appreciated that the instant invention may be used with any vacuum cleaner including an upright vacuum cleaner, a stick vacuum cleaner, a canister vacuum cleaner (with the suction motor and fan assembly positioned in the wand extending from the surface cleaning head to the  
15 canister unit), a backpack vacuum cleaner (with the suction motor and fan assembly positioned in the wand extending from the surface cleaning head to the backpack unit) or the like. Preferably, the vacuum cleaner is battery-operated.

**[0030]** As shown in Figure 1, an upright vacuum cleaner 60 may  
20 comprise a vacuum cleaner head 3 and an upper assembly 62. The vacuum cleaner has a filtration member 11 that is provided in upper assembly 62. In addition, the vacuum cleaner preferably has a rotary brush 1 that is provided in cleaning head 3. In order to provide a low profile for vacuum cleaner head 3, motor and fan assembly 15 is preferably provided as part of upper  
25 assembly 62.

**[0031]** The vacuum cleaner may be provided with an on/off switch, which may be provided at any location of the vacuum cleaner. For example, as shown in Figure 1, on/off toggle switch 43 may be provided on upper assembly 62.

**[0032]** As shown in the Figures, the vacuum cleaner may be constructed as a closed loop circulation vacuum cleaner. In particular, air containing entrained dirt is passed through filtration member 11 to produce a cleaned air stream. Typically, the cleaned air stream in a vacuum cleaner is released to the room. In accordance with the design of Figure 1, the cleaned air stream is recycled through the vacuum cleaner to produce air jets adjacent rotary brush 1 to aid in entraining dirt. If the vacuum cleaner is battery operated, then in order to assist in battery cooling, some or all of the filtered air may be directed at the batteries to provide forced cooling in addition to or in place of separate cooling fans 26, 27. It will be appreciated that even if the filtered air is not used to create air jets, that some or all of the filtered air may be used to cool the batteries.

**[0033]** Referring to Figures 1, 6 and 7, air enters the cleaning head via inlet 64 provided in bottom surface 66 of vacuum cleaner head 3. Dirt from the surface being cleaned is entrained with the assistance of optional rotary brush 1. Suction fan and motor assembly 15 produces an air stream denoted by reference number 4 in Figure 1, which enters duct 2. The dirty air stream passes through inlet duct 2, through up-flow duct 8, through inlet port 10 and into filtration member 11. The filtered air exists filtration member 11 via outlet port 12 through down flow duct 14, through motor and fan assembly 15 and into duct 17 to produce an air stream for recycling (see Figure 1). These members define the air recirculation loop. It will be appreciated that other configurations of the airflow passage through a vacuum cleaner may be provided to produce an air stream for recycle. Some or all of the filtered air may be used to cool optional batteries 5, 6 by being directed to flow over the batteries.

**[0034]** Referring to Figures 6 and 7, duct 17 may consist of a passageway extending through vacuum cleaner head 3 to a position in front of inlet 64. Brush air ejection duct 18 is positioned at the downstream end of duct 17 (see in particular Figures 1 and 8). Preferably, duct 18 distributes the air laterally across the width of vacuum cleaner head 3, preferably along the

entire length of rotary brush 1, and produces a stream 19 of cleaned air for recycle that is directed generally parallel to the floor. The jets are angled to direct the air downwardly towards the floor and rearwardly towards brush 1. Preferably, the air is injected downwardly at an angle A to the horizontal of  
5 between about 0 and 15° (see Figure 7). It will be appreciated by those skilled in the art that duct 17 may be provided at any desired location in cleaner head 3. For example, as shown in Figure 6, duct 17 is provided adjacent upper surface 68 of cleaner head 3. In the embodiment of Figure 7, duct 17 is provided approximate bottom surface 66 of cleaner head 3.

10 **[0035]** The optional air jets produce an air stream, which travels generally parallel to the floor. An advantage to this approach is that the air is generally directed rearwardly towards the inlet of duct 2 so that a substantial portion, and preferably essentially all, of the air exiting ejection duct 18 enters air duct 2 and is therefore recycled. Accordingly, a substantial portion of air  
15 stream 4 entering duct 2 may comprise recycled air. By reducing the amount of air that is exhausted from vacuum cleaner 60, the amount of particulate matter, which is released into the room in which the vacuum cleaner is operated, is also reduced. A further advantage is that the kinetic energy in the exhaust air is used to entrain dirt into air stream 4. As vacuum cleaner 60  
20 may be battery powered, then by using the kinetic energy of air stream 19, the number of batteries required to provide a desired operating time for vacuum cleaner 60 on a single cycle of the batteries may be reduced or, if the same number of batteries are used, then air flow rate may be increased without reducing the operating time of a single cycle of the batteries.

25 **[0036]** It will be appreciated that if the vacuum cleaner is an upright or a stick vacuum cleaner, that cleaning head 3 and upper assembly 62 may be of any design and need not recycle air.

**[0037]** As shown in the preferred embodiment of the figures, the vacuum cleaner is provided with up flow duct 8 and down flow duct 14 that  
30 may be connected to vacuum cleaner head 3 by any means known in the art. Preferably, hollow tubular members, which are in airflow communication with

ducts 2 and 17, may be pivotally mounted to vacuum cleaner head 3. Accordingly, ducts 8 and 14 may seat on these hollow tubular members so as to complete the airflow path. For example, up flow duct 8 and down flow duct 14 may be rigid structural members that are themselves pivotally mounted to vacuum cleaner head 3. Alternately, up flow duct 8 and down flow duct 14 may be mounted on a pivotal airflow tube similar to pivotal airflow valves known in the vacuum cleaner art. Alternately, as shown in Figure 1A, up flow duct 8 and down flow duct 14 may be connected in airflow communication with cleaner head 3 via flexible tubes 9 and 16 respectively. In this latter case, upper assembly 62 is mechanically secured to pivotally mounted cross member 170, which does not form part of the airflow path. Pivotally mounted cross member 170 has axle portions 172 at the opposed ends thereof which are pivotally mounted to sidewalls 174 of cleaner head 3. A similar construction may be used if only a single generally vertically extending duct 8 is provided.

**[0038]** It will be appreciated that ducts 8, 14 are preferably rigid members, which provide a stable support for filtration member 11. Alternately, ducts 8, 14 may be flexible and rigid reinforcing members may be provided to provide a support or platform for filtration member 11 may be supported.

**[0039]** It will be appreciated that if the vacuum cleaner is an upright or stick vacuum cleaner, it may have only one airflow duct 8, 14. It will also be appreciated that ducts 8, 14 need not be spaced apart. For example, they may be positioned side by side. In addition, the same mounting means may be used if there is a single duct 8, 14. For example, if none of the filtered air is recycled, then there is no need to provide a duct 14. In such a case, filtration member 11 may be mounted only on duct 8. Alternately, a support member similar to duct 14, but through which there is no air flow, may be provided so as to provide two supports for filtration member 11. Alternately, if suction motor and fan assembly 15 is cooled by the filtered air as is known in the art, then duct 14 may be provided to deliver filtered air to a motor and fan assembly 15 mounted in cleaning head 3.

**[0040]** It will be appreciated by those skilled in the art that filtration member 11 may be any filtration member known in the art. Preferably filtration member 11 comprises at least one cyclone separator. For example, filtration member 11 may be a cyclone bin or canister whereby inlet port 10 functions to direct the air tangentially into a cyclone bin. It will also be appreciated that filtration member 11 may comprise a plurality of cyclones which may be provided in one or more cyclonic cleaning stages. However, it will also be appreciated that a physical filter element may also be utilized if desired. In such a latter case, the filtration member may be replaceable or washable. If filtration member comprises a cyclone bin, then the cyclone bin is preferably transparent.

**[0041]** Filtration member 11 is optionally secured to upper assembly 62 by upper cover assembly 25 (see Figure 2). Pursuant to such an optional embodiment, upper cover assembly 25 of filtration member 11 may incorporate inlet port 10 and outlet port 12. Upper cover assembly 25 may accordingly provide the lid for filtration member 11 (e.g. if filtration member 11 is a cyclone bin, then upper cover assembly 25 may comprise the lid of the cyclone bin). Inlet port 10 and outlet port 12 are optionally removably mounted on ducts 8, 14 thereby permitting filtration member 11 to be removed from vacuum cleaner 60 for emptying by lifting filtration member 11 and cover 25 upwardly off of ducts 8, 14. In this way, filtration member 11 may be transported while still essentially sealed to a garbage can or refuse container for emptying. It will be appreciated that if the filtered air is not recycled, then the filtered air may be directed to the ambient via outlet port 12. Further, if the vacuum cleaner only has one duct 8, 14, then an outlet port 14 in cover 25 is not required. The air may exit the vacuum cleaner via an outlet port provided in filtration member 11 itself.

**[0042]** Preferably, filtration member 11, once removed from the vacuum cleaner, is emptied by removing cover 25 and inverting filtration member 11 so the contents empty into a garbage can or refuse container by means of gravity. An advantage of this design is that a user need not bend over to

remove filtration member 11 or to empty a cyclone bin. It will be appreciated that, in an alternate embodiment, filtration member 11 may be a porous member that is disposable or washable. Such a filtration member may be designed to be washed while in a rigid housing that defines filtration member  
5 11 or, alternately, filtration member 11 may be disposable. In any such case, a consumer may lift upwardly to remove the filtration member 11 and to then place a new, cleaned or emptied filtration member 11 on ducts 8, 14. It will be appreciated that, if filtration member 11 is not disposable, cover 25 may be permanently affixed to filtration member 11 if a door or other openable cover  
10 member is provided to allow the filtration member to be removed for cleaning or emptying. It will also be appreciated that, if filtration member 11 is disposable, cover 25 may be permanently affixed to filtration member 11 and no other openable cover member need be provided.

**[0043]** Upper cover 25 may be secured to upper assembly 62 by any  
15 means known in the art. In one preferred embodiment, cover assembly 25 is secured in position by at least one magnet and, preferably, a plurality of magnets. For example, referring to Figure 2, duct 8 is provided with a magnet 33. The upper face of magnet 33 may have any desired polarity (i.e. north or south). A magnet 32 is provided in housing of inlet tube 10 so as to be aligned  
20 with magnet 33 when upper cover 25 is mounted on upper assembly 62. The lower or bottom face of magnet 32 has the opposite polarity of the upper or top face of magnet 33. Accordingly, when duct 8 is in airflow communication with inlet port 10, magnets 32 and 33 assist in securing, or secure, cover 25 on duct 8. A similar pair of mating magnets may be provided on duct 14 and  
25 the housing of outlet port 12. It will be appreciated that any other means to removably affix cover 25 to filtration member 11, which is known in the art, may be used. For example, the physical engagement of male and female members may be utilized (e.g. cover 25 may be screwed onto filtration member 11, a release button or catch may be used, a bayonet mount may be  
30 used).

**[0044]** In conventional vacuum cleaners, the cleaned air is fed past the motor prior to the air exiting the vacuum cleaner. In this way, the cleaned air is used to cool the motor such that the air that exits the vacuum cleaner is heated. If the filtered air is recycled, as optionally exemplified herein, and also  
5 used to cool motor 15, then the air in the recirculation air stream exiting duct 17 in cleaner head 3 is heated. The air is therefore preferably cooled as it passes through the vacuum cleaner prior to again encountering motor 15. Accordingly, at least a portion of the airflow passage through the vacuum cleaner is preferably constructed from metal. For example, one or more of  
10 duct 2, flexible hose 9, up flow tube 8, down flow tube 14, flexible tube 19, duct 17 and duct 18, as well the housing for motor 15, may be made from metal. Some or all of these surfaces may be provided with pin fins or other heat dissipation members. In addition, one or more fans may be provided to pass cooling air over the ducts to assist in dissipating the heat. Preferably, a  
15 substantial number of the components of the air flow path and, most preferably, all or essentially all of the components of the airflow path are made from metal. The metal provides a heat sink for adsorbing heat produced by motor 15. By constructing a substantial portion of the vacuum cleaner from metal, a large heat sink is provided. Further, the surface area available for  
20 dissipating the heat to the ambient is also increased.

**[0045]** Optional rotary brush 1 may be driven by any means known in the art. For example, as shown in Figure 1, rotary brush 1 is provided with a brush motor 48, which is drivingly connected to gear 49. Similarly, gear 51 is drivingly connected to rotary brush 1. A fan belt 50 extends around gears 49  
25 and 51 so as to drivingly connect brush motor 48 to rotary brush 1. In such an embodiment, rotary brush 1 may be selectively engaged and disengaged by means of an on/off toggle switch 44. Thus, brush 1 may be shut off when it is not required, such as when an extension hose 21 is in use for above floor cleaning.

30 **[0046]** In an alternate embodiment (not shown), gear 49 may be driven by an air turbine. Preferably the air turbine is provided in air duct 17. An

advantage of this design is that the air turbine would be driven by clean air. Generally, an air turbine comprises a turbine provided within a housing. As clean air would be used to power the turbine, the air gap between the outer end of the blades of the air turbine and the inner wall of the housing may be reduced, thus increasing the amount of power, which may be obtained from an air turbine. In addition, the turbine would be powered by pressurized air (i.e. it is downstream from suction fan and motor assembly 15) as opposed to a negative pressure (e.g. if the air turbine was provided upstream of suction fan and motor assembly 15).

10 **[0047]**        Optionally, duct 2 may include a portion, such as a trough shaped member, for accumulating material prior to the material being fed with the air stream to filtration member 11. For example, if an area of heavy dirt concentration is encountered, the airflow may not be sufficient to entrain all of the dirt. By providing a storage area, the excess material which is not entrained may be stored for entrainment in the air stream once the concentration of material being entrained in air stream 4 decreases.

**[0048]**        In accordance with the instant invention, motor and fan assembly 15 is provided in one of ducts 8, 14. In the embodiment shown in Figure 1, motor and fan assembly 15 is provided in the clean air stream, e.g. in down flow duct 14. Accordingly, the vacuum cleaner is a clean air system (i.e. the air has already been filtered prior to the air encountering the suction fan). It will be appreciated that, in accordance with an alternate embodiment, suction fan and motor assembly 15 may be provided in up flow duct 8. In such a case, motor and fan assembly 15 is provided in the dirty air stream, e.g. in up flow duct 8. Accordingly, the vacuum cleaner is a dirty air system (i.e. the air has already been filtered prior to the air encountering the suction fan). In either case, an advantage of such a preferred design is that the motor and fan assembly is provided exterior to cleaning head 3. Typically, the suction motor and fan assembly is the largest element provided in a vacuum cleaner head thus setting the necessary vertical height of a vacuum cleaner head (i.e. the distance from bottom surface 66 to upper surface 68). By removing suction

fan and motor assembly 15 from cleaner head 3, the vertical height of cleaner head 3 may be reduced. This reduces the profile of cleaner head 3 enabling it to pass underneath furniture having a lower clearance from the floor.

**[0049]** Preferably, suction motor and fan assembly 15 are axial aligned (i.e. the fan is mounted on an axle that extends outwardly from the suction motor and rotates about that axle such that the air passes sequentially through the suction motor and the fan). By positioning suction fan and motor assembly 15 so that its longitudinal direction (i.e. the direction defined by the axle upon which the suction fan is mounted for rotation) is parallel to and in the same plane as the axis of ducts 8 and 14, the profile of upper assembly 62 (i.e. the width of upper assembly 62 from the front surface thereof to the rear surface thereof) may be reduced thus creating a low profile for upper assembly 62. When it is desired to vacuum underneath furniture, upper assembly 62 may be lowered so as to extend rearwardly behind cleaner head 3. In this configuration, the extent to which cleaner head 3 may extend underneath furniture is limited by the extent that upper assembly 62 extends vertically above the surface being cleaned. By positioning suction fan and motor assembly 15 in one of ducts 8 and 14 and aligning the axle of the motor and fan assembly with the longitudinal axis of the duct, the vertical extent of upper assembly 62 when in this configuration is minimized thus increasing the ability of the vacuum cleaner to clean underneath furniture. Also, such an arrangement also reduces the backpressure through the vacuum cleaner, by reducing the number of bends in the airflow passage, and therefore reduces the power required to obtain the same airflow rate through the vacuum cleaner.

**[0050]** If the vacuum cleaner is battery-powered, then the batteries to operate the vacuum cleaner 60 may be provided at any location. Batteries 5, 6 are preferably mounted in cleaner head 3 so as to reduce hand weight of the handle of the vacuum cleaner. For example, referring to Figure 1, two battery sticks 5, 6 are provided in cleaner head 3. The batteries may be individually mounted in vacuum cleaner 60 or they may be provided in one or

more battery sticks as is known in the battery art. The number of batteries will depend upon a number of factors including the operational time of vacuum cleaner 60 on a single charge and the airflow rate produced by motor 15.

**[0051]** The batteries may be provided with an airflow stream to cool the batteries during charging and/or discharging. The cooling air is preferably provided by one or more cooling fans 26, 27 that are positioned to blow cooling air over the batteries 5 and 6. Preferably a fan is provided for each battery stick. As shown in Figure 1, the cooling fans 5, 6 are preferably positioned to blow air longitudinally along the length of a plurality of batteries or a battery stick.

**[0052]** The batteries may be charged in situ. In such a case, the vacuum cleaner is provided with a power cord 45 and a battery charging control circuit. Any charging circuit known in the battery art may be used. In one embodiment, the vacuum cleaner may be configured to also operate on AC power, e.g., when the batteries are discharged. Accordingly, power cord 45 may be any cord known in the vacuum cleaner art. However, if vacuum cleaner 60 is not designed to operate on AC power (i.e. it only operates on batteries 5, 6), then power cord may be relatively short (e.g. from 1 to 10 feet long, preferably from about 1 to 6 feet long and most preferably about 3 feet long). If the vacuum cleaner includes the power control system for charging the batteries (e.g. if may be a part of electronic control board 7), and if the vacuum cleaner operates only on batteries, then power cord 45 may be of a thinner gauge. In such a case, the power cord may be 16 – 18 gauge. Thus, a relatively lightweight cord may be used. Advantageously, this requires a smaller volume to store the cable and a lighter spring may be used on an automatic cord rewind mechanism.

**[0053]** The power cord may be secured in position when it is not in use to charge the batteries by, e.g., a holder 46 provided on one of ducts 8, 14. A battery life indicator 47 may be provided, such as on electronics board 7. Battery life indicator is preferably a read out, and more preferably a digital readout, showing the operating time remaining in the battery cycle.

**[0054]** Batteries 5, 6 are preferably removed prior to the disposal of the vacuum cleaner. Thus, an optional openable panel 34 is preferably provided in cleaner head 3 so as to permit access to the compartment in which batteries 5, 6 are placed. For example, panel 34 may be pivotally mounted to permit it to be opened or it may be removable mounted the vacuum cleaner. Preferably, as shown in Figures 1 and 8, cover 34 is provided in upper surface of cleaner head 3 with the batteries positioned immediately under cover 34. Cover 34 is preferably transparent so as to permit the batteries to be visible to the user. This facilitates the user locating the batteries when they are to be replaced (e.g., the batteries have been subjected to the recommended number of charging cycles) or removed for disposal. Cover 34 may be secured to cleaner head 3 by any means known in the art. For example, cover 34 may be secured by male and female engagement members. Alternately, a plurality of screws 35, 36, 37 and 38 may be provided around the perimeter of cover 34 to secure cover 34 to cleaner head 3.

**[0055]** The vacuum cleaner may include an electronic control board 7, which regulates the power to suction fan and motor assembly 15. Alternately, or in addition, board 7 may also perform other functions. If vacuum cleaner 60 contains optional board 7, then board 7 is preferably provided in cleaner head 3 so that it is visible to the user. To this end, board 7 may be provided under transparent openable cover 34 or under a separate transparent cover (not shown).

**[0056]** It will be appreciated that board 7 and batteries 5, 6 may be provided in a variety of configurations. For example, as shown in Figure 1, board 7 may be provided to the rear of batteries 5, 6. Alternately, as shown in Figure 8, board 7 may be provided in front of batteries 5, 6. In an alternate embodiment, which is not shown, board 7 may be provided between batteries 5, 6.

**[0057]** In order to cool board 7, a fan 28 may be provided to direct cooling air over board 7. Alternately, or in addition, one or both of battery cooling fans 26 and 27 could be utilized to provide cooling air to board 7,

depending upon the position of board 7 and the direction of the air flow which is produced by fans 26, 27. It will be appreciated that if vacuum cleaner 60 is not battery-powered, a board 7 is not required.

**[0058]** Vacuum cleaner 60 may be provided with at least one LED and preferably a plurality of LED's, which are directed so as to function as headlights for the vacuum cleaner. Preferably, each headlight comprises at least 2 LEDs and more preferably from 2 to 8 LEDs and most preferably from 2 to 4 LEDs. Thus a vacuum cleaner may have 2 headlights each of which has, for example, 2 to 4 LEDs.

10 **[0059]** The LEDs may have a light intensity of at least 500 minicandella (mcd). Preferably, the LED's are super bright LED's. Generally, super bright LEDs are considered in industry to be any LED having a light intensity of at least about 1,000 mcd and may have a light intensity of up to 13,000 mcd or more. Preferably super bright LEDs which are used in a vacuum cleaner as  
15 disclosed herein have a light intensity from 1,000 to 10,000 mcd, more preferably from 2,000 to 8,000 mcd and most preferably from 2,000 to 4,000 mcd. Accordingly a headlight having 2 LEDs may have a light intensity of from 4,000 to 16,000 mcd.

**[0060]** Preferably, the LED's are provided directly on board 7 to  
20 minimize wiring of the lights. For example, as shown in Figure 1, LED's 41 and 42 are provided as headlights. The LED's may be provided with or without a reflector to concentrate and direct the light produced by the LED's.

**[0061]** Optionally, filtration member 11 may comprise a transparent or at least translucent portion and, preferably, all of filtration member 11 is  
25 transparent or at least translucent. The use of a transparent or translucent filtration member, in combination with the use of optional LEDs, permits a user to view the interior of the filtration member. Preferably, filtration member 11 is a cyclone bin, such as is known in the art. In this preferred embodiment, vacuum cleaner 60 includes at least one, and preferably a plurality of LED's  
30 (for example LED's 39 and 40), which are angled so as to illuminate the transparent filtration member 11. The LED's may be angled so as to illuminate

the filtration member 11 only when the vacuum cleaner is being used to clean a carpet (the normal carpet cleaning position wherein upper assembly 62 is angled rearwardly behind cleaner head 3), when the vacuum cleaner is in the upright or storage position (e.g. upper assembly 62 extends generally vertically upwardly from cleaner head 3) or when in both positions. The LED's may provide constant illumination or they may be strobed to illuminate the motion of dirt within a transparent or translucent cyclone bin. Preferably the LED's are super bright LED's. In this embodiment, board 7 is preferably positioned so that the LED's may shine upwardly onto the cyclone bin. Accordingly, it is preferred to position board 7 towards the rear of cleaner head 3, (e.g. as shown in Figure 5). To aid in construction, a transparent cover is preferably provided over the portion of board 7 on which LEDs 39, 40 are positioned so that the light from the LEDs is directed at filtration member 11. This is preferably cover 34. If a transparent cover is not provided, then an opening may be provided in upper surface 68 of cleaner head 3. Alternately, the LEDs may be mounted on an exterior surface of the vacuum cleaner.

**[0062]** The vacuum cleaner may have an optional extendible stretch hose 21 for use in above the floor cleaning. In such an embodiment, a valve 20 is provided to connect flexible hose 21 in airflow communication with suction fan and motor assembly 15. As shown in Figure 1, valve 20 may be provided in up flow duct 8. Valve 20 may be any valve known in the art. An advantage of providing valve 20 in duct 8 is that the construction of vacuum cleaner head 3 is simplified. In particular, a valve structure need not be incorporated into the pivotal connection of the upper assembly 62 to cleaner head 3 but may be provided in cleaner head 3 as is common in the industry.

**[0063]** In another embodiment, the optional extension wand for the above floor cleaning hose 21 preferably also functions as the handle for the vacuum cleaner. As shown in Figure 2, according to this alternate embodiment, hose 21 is provided with a rigid tube 22. When mounted on the vacuum cleaner, tube 22 functions as the handle for the vacuum cleaner. When removed from the vacuum cleaner, tube 22 functions as an extension

wand so that the dirty air travels through wand 22 into hose 21 and then into up flow duct 8 via valve 20. An advantage of this construction is that tube 22 may be used both as the handle for the vacuum cleaner as well as an extension for hose 21.

5   **[0064]**        Tube 22 may be removably mounted to upper assembly 62 by any means known in the art. In accordance with an alternate embodiment of this invention, the mount for releasable receiving tube 22 preferably also functions as a carry handle for the vacuum cleaner such as, for example, mount 24 (see Figure 4). In this embodiment, mount 24 comprises a first  
10   portion for releasable receiving tube 22 and a second portion for securing the first portion to upper assembly 62. The first portion may comprise a dovetail receiver 29 which is configured for receiving dovetail 23 which is provided on tube 22. The second portion may comprise one or more rigid rods 52 which extend outwardly from filtration member 11 to provide a securing point for  
15   dove tail receiver 29 and to permit a user to pick up vacuum cleaner 60 using mount 24. It will be appreciate that other releasable engagement means may be utilized. An advantage of this construction is that when tube 22 is detached from the vacuum cleaner as shown in Figures 3 and 4, mount 24 provides a user with a handle which may be used to move vacuum cleaner 60.  
20   Accordingly, a rigid handle is always accessible to the user to facilitate moving the vacuum cleaner regardless of whether tube 22 is in the above floor cleaning position.

25   **[0065]**        Referring to Figure 2, upper assembly 62 may comprise up flow duct 8, down flow duct 14 and one or more cross members to dynamically stabilize ducts 8 and 14 and define a space frame. For example, referring to Figure 2, cross-members 30 and 31 are provided to limit and, preferably, prevent any relative motion of duct 8 with respect to duct 14. Preferably, support member 30, 31 dimensionally stabilize ducts 8 and 14 in two dimensions (i.e. to prevent ducts 8 and 14 bending forward or backwards  
30   relative to each other or to prevent side to side motion of ducts 8, 14). For example, support members 30, 31 may be ovals thus cross-stabilizing ducts

8, 14. Preferably, ducts 8, 14 and supports 30, 31 are made from metal (e.g. aluminum). This provides a rigid, lightweight construction, which may weigh less than conventional plastic cover casings, which are manufactured for vacuum cleaners. It will be appreciated that if ducts 8, 14 are sufficiently stiff,  
5 then no cross-members may be required.

**[0066]** A supplemental filtration media 13 may be provided in down flow duct 14 (see Figures 1 and 2). In accordance with this embodiment, as the cleaned air exits filtration member 11, the air travels through outlet port 12 and then through filtration member 13 as the air travels downwardly through  
10 duct 14. Filtration member 13 may be removed for cleaning or replacement whenever cover 25 is removed from upper assembly 62. When cover 25 has been removed from upper assembly 62, filtration member 13 may merely be lifted upwardly out of duct 14 thereby permitting filter media 13 to be cleaned or replaced. An advantage of this design is that the interior volume of an  
15 airflow duct is utilized to house a supplemental filtration member thereby reducing the overall profile of vacuum cleaner 60.

**[0067]** It will be appreciated by a person skilled in the art that a battery-operated vacuum cleaner may use one or more of the different embodiments disclosed herein and the different embodiment may be combined in any  
20 combination of features to provide a unique vacuum cleaner.